Data S1 - Archaeological background

Further archaeological information on the individuals newly sequenced in this study, the archaeological sites and the general context of Neolithization in SW Asia and Europe. *Related to Figure 1, Table 1 and STAR Methods.*

General information

Anatolia and the Aegean regions appear to have been sparsely populated at the height of the Last Glacial Maximum, ca. 26-20 kya (Adam, 2007; Kozłowski, 1999; Özdoğan, 1997; Perlès, 2000; Runnels, 1988; Runnels and Özdoğan, 2001; Tourloukis and Harvati, 2018). The few cave sites that are securely dated to this period, including Asprochaliko and Kastritsa in Epirus, Theopetra in Thessaly and Franchthi in Argolis, are thought to have been mainly used seasonally as hunting stations and do not show much stratigraphic time-depth (Perlès, 2000). Aurignacian industries are succeeded by Gravettian industries ca. 26 kya in mainland Greece, which however lack the typical Gravette points observed elsewhere in the Balkans (Kozłowski, 1999; Perlès, 2000).

The onset of the northern Hemisphere deglaciation, ca. 20-19 kya (Clark *et al.*, 2009), is associated with major changes in the Aegean region. Eustatic rise in sea-level, in the order of 120 metres by the mid-Holocene (Benjamin *et al.*, 2017; Lambeck, 1995), is thought to have caused the breakup of the Cycladic mega-island (Carter *et al.*, 2019; Papoulia, 2016) and, from ca. 9.5 kya, the flooding of the Black Sea (Esin *et al.*, 2016). Epigravettian industries, characterised by small backed blades with abrupt retouch, perhaps used as inserts for composite projectiles, are found on both sides of the Aegean Basin and in the Antalya Bay (Kozłowski, 2005; Kozłowski and Kaczanowska, 2004). The emergence of new seafaring networks in the Aegean Basin is indicated by the long-distance procurement of obsidian, a volcanic glass found on the island of Melos, from the Final Palaeolithic onwards (Carter, 2016).

First settled communities appear on the Central Anatolian Plateau ca. 15.5-15 kya, shortly before or at the time of the Bølling-Allerød warming phase (Baird, 2012). The Epipalaeolithic site of Pınarbaşı in the Konya Plain, has produced geometric microliths, including lunates, showing influence from contemporary Levantine pre-Natufian and Natufian communities (Baird, 2012). Similar tools appear later on in the Antalya region at Öküzini (Kartal, 2003). Large numbers of marine shells at the site of Pınarbaşı 1,000 m above sea level suggest strong links with the Mediterranean area during the Late Pleistocene, despite the natural boundary formed by the Taurus mountains (Baird *et al.*, 2013). It is not clear how the cold spell of the Younger Dryas affected interactions between the Anatolian Plateau and the Aegean Basin. There is limited evidence for occupation during the interval 12.9-11.7 kya at Pınarbaşı (Baird, 2012; Baird *et al.*, 2013).

Recent surveys in Western Anatolia, in the Karaburun and Bozborun peninsulas (Atakuman *et al.*, 2020; Çilingiroğlu *et al.*, 2020), fill an important gap between Epipalaeolithic traditions on the Mediterranean sea shore, e.g. Öküzini Cave in the Antalya Bay (Kartal, 2003), and contemporary traditions in the North Aegean, e.g. Ouriakos on the island of Lemnos (Efstratiou *et al.*, 2014). Characteristic lithic scatters found in the course of these surveys indicate the presence of foragers in Western Anatolia at the end of the Pleistocene, who shared similar tool sets (e.g. geometric microliths, backed blades and bladelets) and lithic technology, and were presumably integrated in wider Levantine-East Mediterranean-Aegean maritime interactions during the Younger Dryas (Efstratiou *et al.*, 2014). The picture changes at the beginning of the Holocene (coinciding with the start of the Aegean Mesolithic) when Western Anatolia shows stronger connections with the Aegean islands and the Greek mainland. There was limited interaction at that time with aceramic Neolithic sites of Southwest Asia (Çilingiroğlu *et al.*, 2020).

In the Fertile Crescent, the Neolithic or agricultural 'revolution' is thought to have reached a tipping point ca. 11.7 kya, at a time of dramatic post-Pleistocene climate change and expanding carrying capacities (Bar-Yosef, 2011; Bocquet-Appel and Bar-Yosef, 2008; Shennan, 2018). Sites in what is today Southeast Turkey, Northern Syria and Western Iran, are among the firsts to show unambiguous signs of ungulate domestication (Peters *et al.*, 1999; Zeder, 2017). From ca. 10.6 kya, a range of founder crops and animals from the Fertile Crescent are introduced piecemeal among sedentarizing communities of Central Anatolia and Cyprus (Arbuckle *et al.*, 2014; Baird, 2012; Vigne *et al.*, 2012). The small 'aceramic' site of Boncuklu, is thought to be one of the oldest communities on the Anatolian plateau to practise small-scale plant cultivation, starting ca. 10.3 kya (Baird *et al.*, 2018).

The Western half of the Anatolian Peninsula does not transition to farming before about 8.7-8.6 kya (Brami and Horejs, eds., 2019; Weninger *et al.*, 2014 and references therein). **Barcın** and **Aktopraklık** are among the first Neolithic communities in NW Anatolia (Gerritsen and Özbal, 2019; Karul and Avci, 2011; Özdoğan, 2011). The new subsistence economy, characterised by a near-complete 'package' of domestic crops and animals, is abruptly introduced by farmers, who live on settlement mounds, build elaborate rectilinear houses, and use pressure technology to create sets of tools for domestic activities, such as plant harvesting (Arbuckle *et al.*, 2014; Çakırlar, 2013; Çilingiroğlu and Çakırlar, 2013; Horejs *et al.*, 2015). Broadly comparable early Neolithic communities appear all over mainland Greece and Crete approximately within a century (van Andel and Runnels, 1995; Douka *et al.*, 2017; Halstead and Isaakidou, 2020; Perlès, 2001; Perlès *et al.*, 2013; Weiberg *et al.*, 2019). **Nea Nikomedeia** belongs to an advanced phase of that expansion.

From ca. 8.2 kya, at a time of rapid climate change, farming spreads northwards to the Central Balkans, along the Struma, Mesta and Vardar-Morava-Danube corridors (Ivanova *et al.*, 2018; Krauß *et al.*, 2018). The distribution of ^{14}C-dated Neolithic sites shows a gradient away from the main river axes, with Alpine regions left mostly off-course during the initial phase of Danube expansion (Davison *et al.*, 2006). Neolithic groups settled in enclaves along the main river system all the way to the Carpathian Basin, for instance at **Vinča-Belo Brdo** and **Grad-Starčevo** near today's Belgrade. The narrow stretch of the Danube river known as the Danube Gorges or Iron Gates bears witness to important cultural and genetic interactions between indigenous sedentary fishers and incoming farmers at **Vlasac** and **Lepenski Vir** (de Becdelièvre *et al.*, 2020; Borić, 2011, 2016; Jovanović *et al.*, 2019; Stefanović, 2016).

The emergence of the Linearbandkeramik (LBK) in Central Europe ca. 7.5 kya involves a major redefinition of the Neolithic pattern of existence, with settlement mounds now abandoned in favour of flat extended sites. A steep decline in crop diversity is observed north of the Alps, with a number of southerly-oriented species like lentils and chickpeas dropped from the Neolithic 'package' (Colledge *et al.*, 2019). Typical long houses appear in this period. The dead are increasingly buried in formal cemeteries outside settlement areas, such as **Kleinhadersdorf** in Lower Austria (Neugebauer-Maresch and Lenneis, 2015). Most LBK burials date to an advanced phase of the early Neolithic after ca. 7.2 kya.

Increased competition between different LBK communities of Central Europe is thought to have resulted in the first large-scale 'massacres' (Shennan, 2018). **Asparn-Schletz** and **Herxheim** show signs of interpersonal violence on a scale that has never been observed before in the Neolithic (Boulestin and Coupey, 2015; Boulestin *et al.*, 2009; Orschiedt and Haidle, 2012; Teschler-Nicola, 2012). At **Asparn-Schletz**, one LBK community is thought to have attacked another, resulting in tens of dead lying unburied in the latest ditch system (Windl, 2009). In **Herxheim**, several LBK groups are thought to have come together to participate in a large-scale ritual event, involving the systematic killing and dismembering of hundreds of people from outside the community, whose bones were then meticulously smashed into small fragments whereas the skulls were manipulated leaving only the calottes intact. Besides the human victims, which are thought to represent human sacrifices, precious pottery and stone tools were also destroyed, underlining the ritualistic character of the event. Body fragments, calottes and artefact remains were finally deposited in large finds concentrations in two ditches surrounding the former settlement (Zeeb-Lanz, 2019a; Zeeb-Lanz, 2019b).

Context of the samples

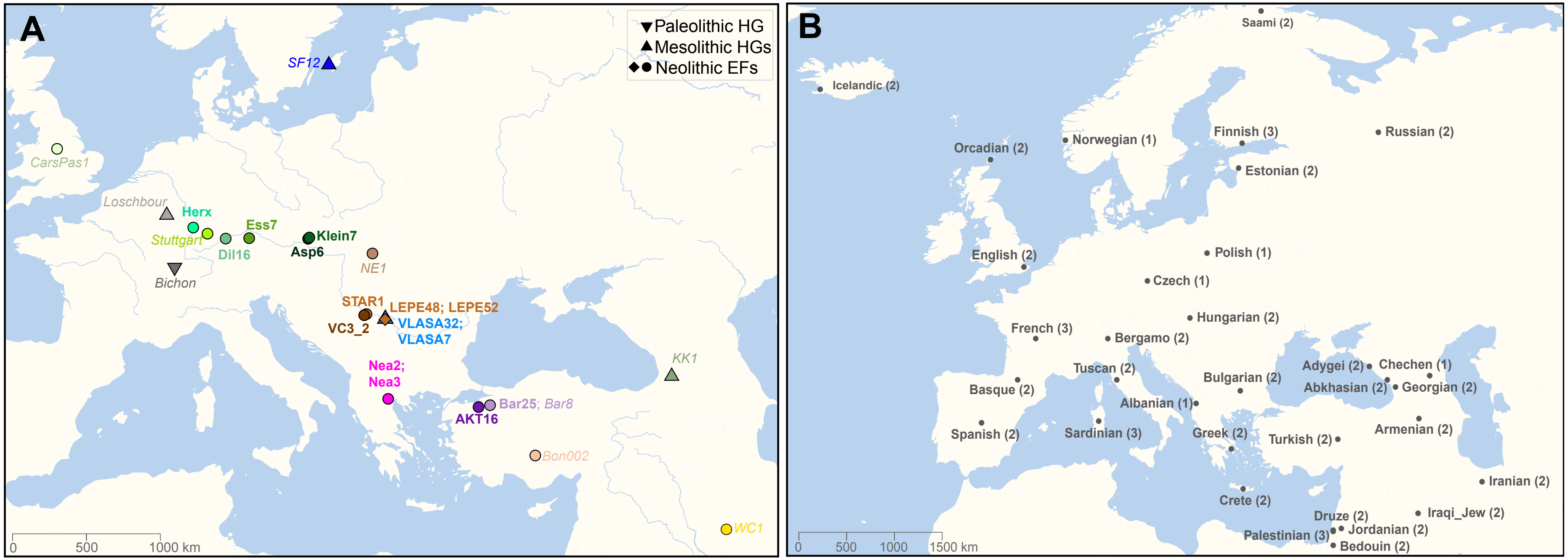

Figure D1_1 - Geographical distribution of all genomes included in this study. (**A**) 25 high-quality ancient genomes: 15 newly sequenced (bold) and 10 from the literature (italic). (**B**) 65 modern genomes from Europe and Southwest Asia that were selected within the SGDP panel. For comparison, we also included the genomes of two Africans (Mende), six Asians (two Tubalars, two Kapus, two Hans), two Oceanians (Papuans) and two Amerindians (Karitianas) from the SGDP panel.

Table D1_1 - Archaeological information on the new palaeogenomes included in this study.

The ^{14}C dates were calibrated in OxCal 4.4.2 (Ramsey, 2009) using the IntCal20 calibration curve (Reimer *et al.*, 2020). Dates from Danube Gorges individuals with associated $\delta^{15}N>8.3‰$ were corrected for freshwater reservoir effect (FRE) following the method described by (Cook *et al.*, 2001), later amended by (Bonsall *et al.*, 2015). Both new (marked with an asterisk) and previously published dates are reported here.

Sample ID	Site	Phase	Archaeological/ Burial ID	14C Lab Number, uncal. age BP	cal. BP 2σ
VLASA7	Vlasac	Late Mesolithic	Burial 31	AA-57777: 8196 ± 69 (*(102)*: Tab.1) FRE corrected: 7707 ± 93	8764-8340
VLASA32	Vlasac	Late Mesolithic	Burial 16	*MAMS-46044: 9064 ± 27 FRE corrected: 8596 ± 66	9741-9468
AKT16	Aktopraklık	Anatolian Late Neolithic (Aegean Early Neolithic)	89 D 14.1	MAMS-25475: 7792 ± 28 (*(105)*: Tab.7)	8635-8460
Bar25	Barcın	Anatolian Late Neolithic (Aegean Early Neolithic)	M10-455 (BH 43347 (lot. 1856))	*MAMS-46043: 7506 ± 27	8384-8205
Nea2	Nea Nikomedeia	Early Neolithic	#7	MAMS-24004: 7290 ± 31 (*(106)*: Tab. 2.4)	8173-8023
Nea3	Nea Nikomedeia	Early Neolithic	T XII	*MAMS-46042: 7388 ± 27	8327-8040
LEPE48	Lepenski Vir	Transformational/ Early Neolithic	Burial 122	OxA-16005: 7190 ± 45 (Borić 2011: appendix 1), FRE corrected: 7115 ± 46	8017-7844
				OxA-16006: 7190 ± 40 (Borić 2011: appendix 1), FRE corrected: 7127 ± 41	8020-7860
				OxA-16005 + OxA-16006: 7122 ± 31 X2-Test: df=1 T=0.0(5% 3.8)	8012-7867
LEPE52	Lepenski Vir	Early-Middle Neolithic	Burial 73	BA-10652: 7265 ± 30 (Borić and Price 2013: ESM), FRE corrected: 6983 ± 47	7931-7693
STAR1	Grad-Starčevo	Early Neolithic (Starčevo)	Grave 1	BRAMS-2407: 6671 ± 27 *(107)*	7589-7476
VC3-2	Vinča-Belo Brdo	Early Neolithic (Starčevo)	Grave V (group burial)	OxA-28634/UBA-22463: 6581 ± 34 (*(109)*: Tab. 2)	7565-7426
Asp6	Asparn-Schletz	Early Neolithic (LBK)	Ind 44 (646 Part 152, Schnitt 10 LM70)	*MAMS-46038: 6657 ± 26	7580-7473
				*MAMS-48728: 6627 ± 35	7573-7430
				MAMS-46038 + MAMS-48728: 6646 ± 21 X2-Test: df=1 T=0.5(5% 3.8)	7575-7474
Klein7	Kleinhadersdorf	Early Neolithic (LBK)	Grave 56 (25,937)	*MAMS-46040: 6208 ± 27	7244-7000
				VERA-2167: 6090 ± 50 (*(108)*: tab.36)	7158-6796
				MAMS-46040 + VERA-2167: X2-Test: df=1 T=4.277(5% 3.8) - combination fails at 5%	–
Ess7	Essenbach-Ammerbreite	Early Neolithic (LBK)	Grave 2	–	–
Dil16	Dillingen-Steinheim	Early Neolithic (LBK)	Grave 24, Befund 24 (1997)	*MAMS-46039: 6200 ± 25	7235-6998
Herx	Herxheim	Early Neolithic (LBK)	281-19-6	*MAMS-46041: 6189 ± 25	7164-6993

Aktopraklık

Excavated since 2004 by a team from the Prehistory Department of the University of Istanbul, Aktopraklık is one of the oldest Neolithic sites in Northwest Anatolia (Karul and Avci, 2011). The site is located on one of the terraces overlooking the eastern edge of Lake Uluabat, ca. 25 km west of the city of Bursa. Unusually for the Anatolian Neolithic, Aktopraklık is a flat extended settlement and cemetery, consisting of three distinct areas (Aktopraklık A, B and C). Previously-published AMS dates on human bones indicate that occupation spanned from the early 9th to mid-8th millennium BP (Hofmanová, 2017; Karul and Avci, 2011). The oldest levels (Area C) are characterised by circular semi-subterranean structures, ca. 3-6 m in diameter, which were perhaps used as houses or 'huts' and fit the coastal Fikirtepe tradition defined by Mehmet Özdoğan in the NW Anatolia region (Özdoğan, 2011: S422-S423). Previous studies have indicated that the first inhabitants at Aktopraklık, including the individual sampled here, consumed terrestrial C_3 food and practised animal husbandry (Budd *et al.*, 2013, 2018; Çakırlar, 2013).

In the Neolithic phase, the dead were buried in close proximity to houses or immediately beneath them, sometimes with monochrome pottery, bone tools and stone beads (Alpaslan-Roodenberg and Roodenberg, 2020). Individual 89D 14.1. (AKT16; Fig. D1_2) stems from a double burial and was identified genetically as female. This middle-aged to old adult was buried in a contracted position on her left side with the head oriented to the east – facing south (Alpaslan-Roodenberg, 2011: 25). The head of this individual was placed on the feet of the adult female 17.1, who shared the same grave. There were no grave goods as such except faunal remains in the pit fill and on the skeletons. Direct dating of this skeleton (MAMS-25475: 7792 ± 28 BP) indicates that she died ca. 8635-8460 cal. BP at 2σ - in other words at the very beginning of farming expansion in the region (Hofmanová, 2017: tab 7; tab 21).

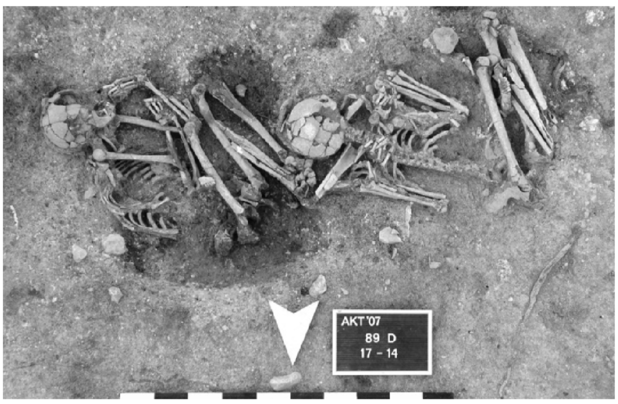

Figure D1_2 - Aktopraklık: double burial 89D 17.1 and 14.1 (image credit: Alpaslan-Roodenberg, 2011: fig.9, reproduced with permission of *Anatolica*)

Barcın

Barcın Höyük is a multi-layered mound in Northwest Anatolia, excavated from 2005 to 2015 by an international team under the auspices of the Netherlands Institute in Turkey (Gerritsen and Özbal, 2019). The site, which has already featured in several ancient DNA studies (Hofmanová *et al.*, 2016; Lazaridis *et al.*, 2017; Mathieson *et al.*, 2015), is located in the Yenişehir Basin, between the Iznik Lake and the Uludağ Mountains, providing convenient access to the heart of the Anatolian Peninsula. A series of over 30 radiocarbon dates place the beginning of the occupation of Barcın (levels VIe and VId1) 8,550 cal. BP (Weninger *et al.*, 2014). Despite its early date, Barcın is characterised from the outset by a fully agrarian economy, based on cultivated cereals and pulses, while domestic cattle and sheep dominate the faunal assemblage (Arbuckle *et al.*, 2014).

The settlement structure in the early phases consists of a row of rectilinear mud and timber houses facing a central courtyard. The dead are generally buried in the courtyard, except neonates and infants who are also buried within or directly outside houses, next to walls. The individual M10-455 sampled here (Bar25) was found with several other infant burials in a narrow annex of structure 19, a structure which had an unusual red-coloured floor – a feature often associated with "special purpose" buildings in Southeast and Central Anatolian Neolithic sites (Gerritsen *et al.*, 2020). This and neighbouring buildings of level VId1 were all destroyed by a fire, which happened no later than 8350-8325 cal. BP according to the latest radiocarbon determinations. Culturally speaking, Barcın demonstrates early and ongoing connections with Central Anatolia, visible in such elements as the production and uses of ceramics, the incorporation of cattle and goat horns in the architecture and the predominance of Central Anatolian sources in the obsidian assemblage (Gerritsen and Özbal, 2019). Burial M10-455 is a single primary inhumation in a small pit. The young infant, genetically identified as male, was placed in an east-west orientation with cranium to the east. There were no grave goods associated with the burial. The skeleton has been directly dated to 8384-8205 cal. BP at 2σ (MAMS 46043: 7506 ± 27 BP).

Nea Nikomedeia

The early Neolithic mound of Nea Nikomedeia in Northern Greece was excavated from 1961 to 1964 by Robert J. Rodden under the auspices of the British School at Athens. The site, which is located ca. 10.5 km north-east of the city of Veroia in the plain of Macedonia, has produced three building phases consisting of broadly overlapping rectilinear timber structures with foundation trenches (Pyke and Yiouni, 1996; Rodden, 1964, 1965; Rodden *et al.*, 1962). The excavation project marked an important turning point for research on Macedonian prehistory, due to the involvement of multiple teams of international scientists and the recognition of Nea Nikomedeia as one of “the oldest Neolithic sites found in Europe” (Rodden, 1965: 83). An unusually large building at the site, described by the excavators as a “shrine”, was destroyed in a violent fire with all its contents, including elaborate female figurines (Rodden and Rodden, 1964: 564). Based on a series of radiocarbon dates obtained in the 1990s on archival samples of domestic cereals and bones, the early Neolithic site of Nea Nikomedeia has been dated to the second half of the 9th millennium BP, perhaps starting ca. 8400 cal. BP.

The funerary record of the site has never been published in detail, although preliminary reports suggest that at least 35 individuals came from regular burials inside the early Neolithic settlement, including 13 adults, 13 children and nine infants; in addition, 31 adults and 21 children were represented by single bones or partial skeletons (Angel, 1973: 103; Triantaphyllou, 2001: tab. 4.5; tab. 4.7). Most burials were single primary inhumations placed in earth pits, in contracted position under house floors or in-between houses (Rodden, 1964: 605).

The two individuals sampled here, both genetically females, have been radiocarbon dated to 8327-8040 cal. BP (Nea3, MAMS-46042: 7388 ± 27 BP) and 8173-8023 cal. BP (Nea2, MAMS-24004: 7290 ± 31 BP). Based on the macroscopic examination of the skeletal remains, which are in extremely poor condition, both individuals appear to be early infants, respectively ~6-9 (T XII, Nea3) and ~18 months old (#7, Nea2). The latter shows enlarged nutrient foramina on the diaphyses and flaring of the epiphyseal ends of the long bones. These skeletal changes have been linked to hereditary anaemias such as thalassemia and sickle cell anaemia (Hershkovitz *et al.*, 1997; Lagia *et al.*, 2007; Ortner, 2003). Differential diagnosis for flaring and frayed metaphyseal cortex also includes rickets/osteomalacia and genetic syndromes (Ortner, 2003).

Vlasac

Set like its neighbour Lepenski Vir in the spectacular landscape of the Danube Gorges, Vlasac has been first salvage-excavated by D. Srejović and Z. Letica in 1970-1971; a team led out by D. Borić returned to the site in 2006-2009 to conduct new excavations on the unsubmerged section of the settlement. The individuals analysed in this study both originate from the old Srejović excavation area. Remarkably, some of the architectural practices observed at Lepenski Vir, such as trapezoidal floor plans, rectangular hearths and red limestone floors, are already present (if only in basic form) in Late Mesolithic contexts at Vlasac.

Burial 31 (VLASA7) is a typical Mesolithic burial in extended supine position (Fig. D1_3A). The burial, which belongs to Phase I, truncated the eastern side of Dwelling 2, which is dated to the first half of the 9th millennium BP according to Borić *et al.* (Borić *et al.*, 2008: 273-274). A single radiocarbon date (AA-57777: 8196 ± 69 corrected 7707 ± 93 BP) from the skull provided a range of 8764-8340 cal. BP at 2σ after correction for freshwater reservoir effect (Borić, 2011: appendix 1). This adult individual, identified as genetically male (Hofmanová, 2017: tab S3), has produced high stable isotope values ($\delta^{15}N$: 16.1‰ and $\delta^{13}C$: -20.7‰) consistent with substantial intake of aquatic proteins (Borić, 2011: appendix 1). Previously published $^{87}Sr/^{86}Sr$ ratios indicate a local range for this individual (Borić and Price, 2013: SI tab. 1). Mesolithic Burial 16 (VLASA32) consists of the disarticulated remains of an old adult male (Fig. D1_3B), radiocarbon dated to 9741-9468 cal. BP at 2σ after correction for freshwater reservoir effect (MAMS-46044: 9064 ± 27 corrected 8596 ± 66 BP). The previously published $^{87}Sr/^{86}Sr$ ratio for Burial 16 is consistent with a local range (Borić and Price, 2013: SI tab. 1).

Figure D1_3 - Vlasac. (**A**) Burial 31 in extended supine position. (**B**) Remains of Burial 16 (image credit: Documentation of the Laboratory for Bioarchaeology, Faculty of Philosophy, University of Belgrade).

Lepenski Vir

Lepenski Vir is one of the most emblematic Mesolithic and early Neolithic sites in Europe. Completely excavated from 1965 to 1970 by Dragoslav Srejović, in advance of the construction of the hydroelectric Đerdap I dam in the Danube Iron Gates, Lepenski Vir has since been extensively re-studied by teams from the Universities of Belgrade and Cambridge. The osteological and mortuary evidence have been the focus of a number of recent high-impact publications, making the site an ideal case-study to address the transition from Mesolithic to Neolithic (Borić, 2016; Hofmanová, 2017; Stefanović and Borić, 2008). Occupied from the 12th millennium BP by foragers and fishers, Lepenski Vir bears witness to important changes after 8,150 cal. BP, when pottery appears in the Central Balkans. The more iconic trapezoidal houses with limestone floors, sculpted boulders and subfloor burials belong to this period. Despite the arrival of early Starčevo farming communities in the region, there are no domesticates beside dogs at Lepenski Vir before Phase III, dated to the early 8th millennium BP (Borić and Dimitrijević, 2007: 52).

The two individuals reported in this study, which are very close chronologically, belong to the Transformational/early Neolithic phase I-II (Burial 122) and the early-Middle Neolithic Phase III (Burial 73). Burial 122 (LEPE48) is a stray sub-adult skull without a mandible (15-18 year old, genetically male) discovered in the packing layer between the superimposed floors of trapezoidal houses 47 and 47', at the centre of the settlement (Fig. D1_4). Two radiocarbon dates (OxA-16005: 7190 ± 45 corrected 7115 ± 46 BP and OxA-16006: 7190 ± 40 corrected 7127 ± 41 BP) directly date this skull to 8012-7867 cal. BP at 2σ after correction for reservoir effect (Borić, 2016: 211). Strontium isotope analysis has previously indicated that skull burial 122, which bears intriguing cut marks, falls just outside the local range (Borić and Price, 2013: Fig. 3).

Burial 73 (LEPE52) is a single primary inhumation of a genetically adult male (Hofmanová, 2017: tab 22), ca. 30-40 years old, crouched on his right side in the northern zone of Lepenski Vir, outside the habitation space (Fig. D1_5). A single radiocarbon date (BA-10652: 7265 ± 30 corrected 6983 ± 47 BP) places Burial 73 to 7931-7693 cal. BP at 2σ after correction for freshwater reservoir effect (see Borić and Price, 2013: ESM; Borić, 2016: tab 1.1; 293). Isotopically, Burial 73 is in the local range (Borić and Price, 2013: fig.3). Starčevo pottery and a green stone pendant were recovered in the fill of this burial.

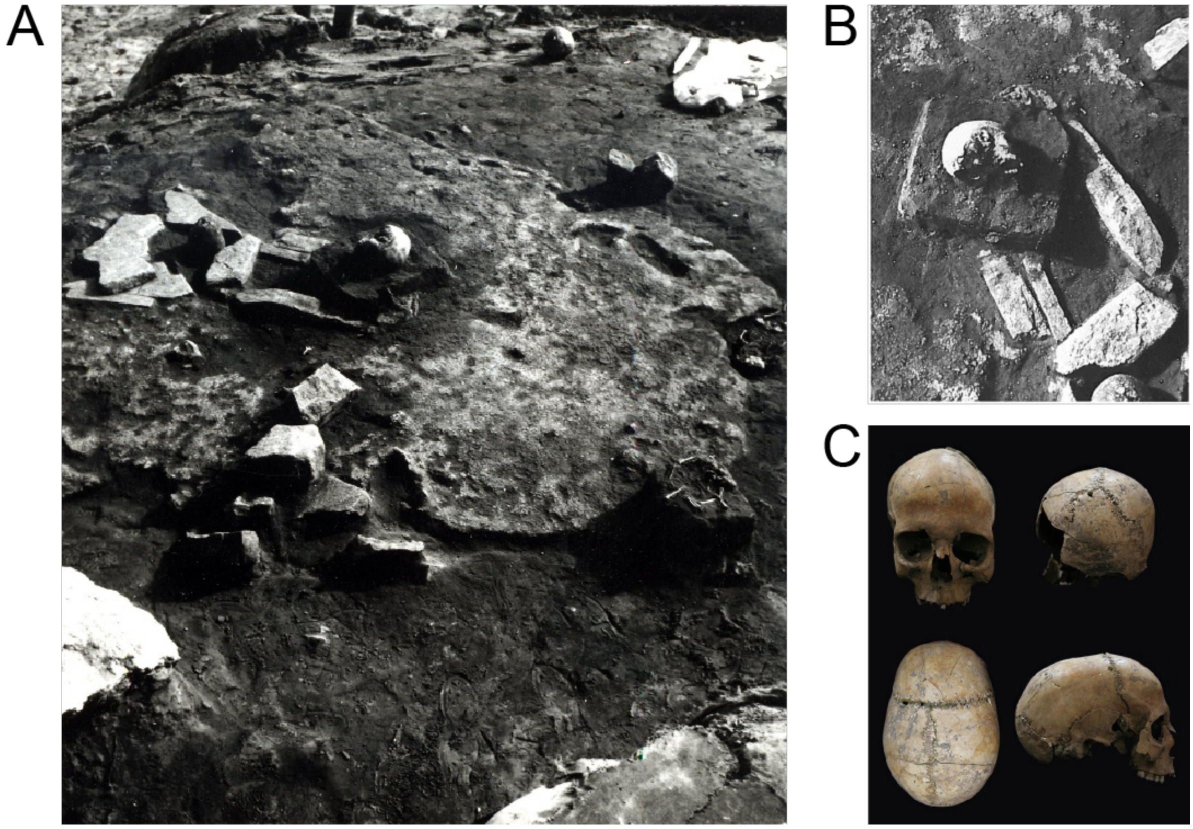

Figure D1_4 - Lepenski Vir.
(**A**) Burial 122; the skull with house 47'; (**B**) detail; (**C**) frontal, occipital, vertical and lateral projection (image credit: Stefanović, 2016: Fig. 68-69, reproduced with permission).

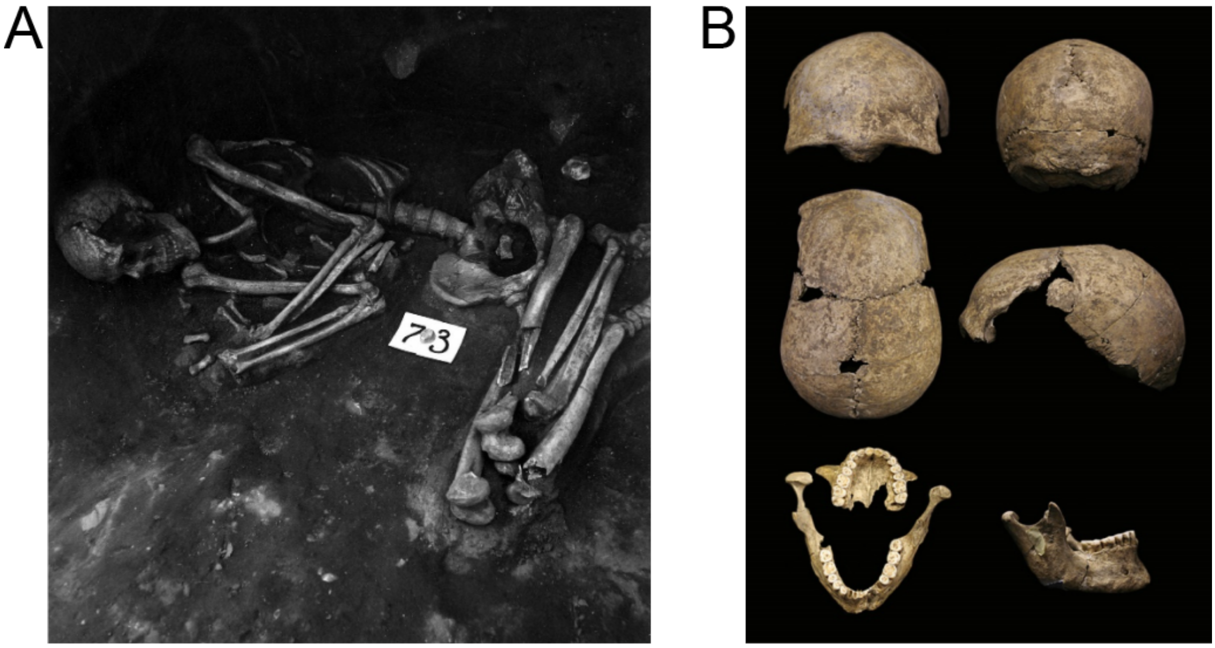

Figure D1_5 - Lepenski Vir.
(**A**) Burial 73; (**B**) skull of Burial 73, frontal, occipital, vertical and lateral projection and maxilla and mandible (image credit: Stefanović, 2016: Fig. 52-53, reproduced with permission).

Grad-Starčevo

Situated just across Vinča on the other side of the Danube, along an old bank of the river that was liable to flooding until the turn of the 20th century, the type-site for the Starčevo culture in the Central Balkans has been repeatedly excavated since 1928 by teams from the National Museum in Belgrade (Ehrich, 1977: 59). The first systematic excavations were carried out in 1932 by Vladimir Fewkes with funding from the Peabody and Fogg Museums at Harvard and from the American School of Prehistoric Research (Ehrich, 1977: 60). New excavations took place in 1969-1970 under the direction of Draga Garašanin and Robert Ehrich. In 2003-2004, the Institute for the Heritage Protection in Pančevo conducted a series of small trench excavations totalling about 70 m^2 (Jovanović, 2017: 54).

The site, which has been traditionally ascribed to the later Starčevo period, is radiocarbon-dated to ca. 7900-7350 cal. BP (Whittle *et al.*, 2002). Grad-Starčevo has documented a range of domestic activities typically associated with Neolithic societies, including food-production, some degree of sedentism with 'pit-houses' (though no postholes can convincingly be associated with them) and a rich ceramic assemblage including monochrome and painted vases (Ehrich, 1977: 64-65). Domestic animals include cattle, sheep/goat and pigs (Clason, 1980: tab 5).

The individual sampled for this project, Skeleton 1, Grave 1 (STAR1), which is now radiocarbon dated to 7589-7476 cal. BP at 2σ (BRAMS-2407: 6671 ± 27 BP), was discovered during the 2004 excavation season at the bottom of the pit dwelling in trench 5/2004 (Jovanović, 2017: appendix 1). Identified as an older female, ca. 55-60 years old, Skeleton 1 was buried in a contracted position on the right side, without any grave goods (Fig. D1_6). New isotopic values for this individual indicate that she had a mostly terrestrial diet (Porčić *et al.*, 2020). A 5-7 year old child was found nearby, at a distance of 0.6 m on the same level (Jovanović, 2017: appendix 1).

Figure D1_6 - Grad-Starčevo. (**A**) Grave 1; (**B**) detail (image credit: Documentation of the Laboratory for Bioarchaeology, Faculty of Philosophy, University of Belgrade; picture of the skeleton: Jugoslav Pendić).

Vinča-Belo Brdo (Starčevo phase)

Located on the right bank of the Danube, ca. 14 km east of Belgrade, the site of Belo Brdo in Vinča has been excavated from 1908 onward by Miloje Vasić, rapidly becoming the type-site for the eponymous Vinča culture in the Central Balkans. The site is unusual in being the only known tell or settlement mound in a radius of 100 km, at 8 m above the Danube river valley (Chapman, 2000: 205). New excavations began in 1978 under the auspices of the Serbian Academy of Sciences and Arts (Tasić *et al.*, 1990). The site was first occupied in an advanced phase of the Starčevo period before the development of the Vinča culture.

The individual sampled for this project, individual V (VC3-2), stems from a collective tomb (pit Z) in the lowermost level of the mound (Fig. D1_7). The partial commingled remains of at least 12 individuals, including two females and nine indeterminate adults and sub-adults, were associated with this feature (Jovanović, 2017: 58-59), which has been variously interpreted as an "ossuary", a "pit-dwelling" and a "tomb with entrance hall – dromos" (Borić, 2009: 230-232). Individual V forms part of the collection studied by I. Schwidetzki in 1937, which was damaged during the bombing of Belgrade in WWII (Jovanović, 2017: Appendix 1). In her PhD thesis, Jelena Jovanović indicates that individual V consists exclusively of skull fragments; age could be inferred to between 25-35 years based on tooth abrasion; isotopic values of $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$ provided by Nehlich *et al.* (2010) are consistent with a terrestrial diet with a small intake of aquatic proteins (Jovanović, 2017: Appendix 1). Individual V has a genetic signature consistent with being male (Hofmanová, 2017: tab S3).

The Starčevo burials have been radiocarbon dated in the 2000s to between 7669-7324 cal. BP at 2σ after correction for reservoir effect (Tasić *et al.*, 2015, 2016). Given the $\delta^{15}N$ values of between +10.3-13.6‰ (Δ = 3.3‰; n = 6) for some of these individuals, possibly indicating some intake of freshwater fish (Borić, 2009: 230-231; Nehlich *et al.*, 2010: tab.3; Jovanović *et al.*, 2019: ESM3), a small reservoir correction factor equivalent to that used in the Danube Gorges was applied by Tasić *et al.* (2016).

Figure D1_7 - Vinča: collective tomb of the Starčevo period (image credit: Documentation of the Laboratory for Bioarchaeology, Faculty of Philosophy, University of Belgrade)

Asparn-Schletz

Excavated from 1983 to 2005 by Helmut Windl, Niederösterreichisches Landesmuseum, the site of Asparn-Schletz, in the Lower Austrian Weinviertel, is one of the most enigmatic Linearbandkeramik culture (LBK) sites. Schletz is a large settlement enclosed by two ditch systems, a trapezoidal one, ca. 400 m in diameter, and an oval one, ca. 330 m in diameter (Windl, 2009: 191). The latter was renewed several times, broken by several entranceways or earthen bridges and probably reinforced by a palisade. There is evidence for habitation, in the form of long houses, and food production at the site (Windl, 1999: 56). In its latest phase, the oval ditch system provided a final resting place for approximately 130 individuals, who were given no formal inhumation and often lay in unnatural contortions.

The skeletons, which have been studied by anthropologist Maria Teschler-Nicola and colleagues, bear multiple traumas of perimortem origin, mostly caused by blunt force to the skull and arrow piercing (Teschler-Nicola, 2012). Some perimortem fractures on postcranial remains were also identified. It is likely that the corpses remained unburied for a period of time as limb extremities are often missing, and bones bear gnaw marks. Presumably the 'massacre' was a single event which happened some time towards the end of the LBK, ca. 7150-6900 BP, based on a sequence of 15 internally consistent ^{14}C dates on human bones (Wild *et al.*, 2004: Table 1). Young females are underrepresented in the mortality profile (only five females to 17 males in the 20-40 years age bracket). The abandonment of the settlement appears to have coincided with the 'massacre' itself; the final ditch system was partially infilled with settlement debris (Windl, 2009: 192). Up to now ca. 20 regular graves have been recorded in the ditch and the settlement beside the individuals of the massacre. Most individuals buried in graves were subadults. Regular graves came from an earlier LBK level.

The individual sampled for this project, ind. 44 (Asp6) from the 1987 excavation season, comes from the juncture of the two ditches, which precisely overlap at this point, and possibly belongs to the 'massacre' context. The individual has been identified, both anthropologically and genetically, as male. Age at death has been recorded as between 35-45 years. The cranial remains exhibit not only an old healed trauma, but also perimortal fractures. In the course of the new Forschung-Technologie-Innovation (FTI) Strategy project, supported by the Lower Austrian government, the excavation records and other documents are being systematically re-investigated. For this burial, earlier excavation records indicate that the individual was "buried in the ditch, E-half".

The new ^{14}C date reported here, which stems directly from the skeleton sampled (MAMS-46038: 6657 ± 26 BP, 7580-7473 cal. BP at 2σ) is significantly older than anticipated, based on its stratigraphic location on top of other slain individuals (F. Pieler, comm.). The ^{14}C date was confirmed by repeating the graphitization and measurement, using collagen prepared for MAMS-46038 (MAMS-48728: 6627 ± 35 BP, 7573-7430 cal. BP at 2σ). The ongoing FTI project, led by Franz Pieler and Maria Teschler-Nicola, will help to clarify the dating of this individual.

Kleinhadersdorf

Discovered in 1911, the Linearbandkeramik cemetery of Kleinhadersdorf near Poysdorf, in the Lower Austrian Weinviertel, has been first excavated in 1931; more systematic excavations to rescue the site from erosion and agricultural activities took place in 1987-1991, under the directorship of Johannes Wolfgang Neugebauer from the Austrian Bundesdenkmalamt. The findings, including the results of anthropological analyses, have been recently published in a monograph (Neugebauer-Maresch and Lenneis, 2015, and references therein). The cemetery was located some 150-200 m north of the nearest LBK settlement, on a slope at the edge of a very fertile loess basin. Based on ceramic typology and a sequence of 19 radiocarbon dates, the site has been dated to ca. 7250-6750 BP, spanning from the phase LBK I/II to phase LBK III; at least four burial phases could be identified (Neugebauer-Maresch and Lenneis, 2015: 110; 151-152).

Of the more than 60 graves excavated at the site, 41 have provided detailed anthropological information (Tiefenböck and Teschler-Nicola, 2015). Most were single primary inhumations in a contracted position on the left side (Neugebauer-Maresch and Lenneis, 2015: 57-59). There was some variation in the layout and orientation of the bodies, and at least 12 were buried on their backs. Beside regular graves, there were 26 'empty' ones, which contained no or very few human remains, bringing the total number of individuals recorded at the site to 62. Intriguingly, several features point to a local continuation of Mesolithic traditions, including microliths, arrowheads, and deposits of red ochre in some of the grave pits (Mateiciucová, 2015: 115-118). The individual sampled (Klein7) comes from grave 56 (Fig. D1_8) and was buried in a contracted position on the left side, with the head to the northeast, the mouth wide open

(Neugebauer-Maresch and Lenneis, 2015: plate 36). The arms were folded together, with the left hand in front of the face covered in red ochre powder. The individual was identified as a mature female, ca. 40-50 years old, and shows signs of degeneration on the spine (Tiefenböck and Teschler-Nicola, 2015: 341). There were perimortem fractures on the right humerus and right fibula. Ceramic sherds from the grave fill show an early Želiezovce ornament and should be dated to shortly after phase IIb of the site (Neugebauer-Maresch and Lenneis, 2015: 98). The new radiocarbon date (MAMS-46040: 6208 ± 27 BP) is slightly older than the one published before for grave 56 (Stadler, 2015: tab.36; VERA-2167: 6090 ± 50 BP) and is consistent with the stratigraphy of the site, indicating that Klein7 should be dated to 7244-7000 cal. BP at 2σ. Previously published $\delta^{13}C$ (-20.0‰), $\delta^{15}N$ (9.8‰) $^{87}Sr/^{86}Sr$ (0.709612) values for this individual suggest that she sourced her food nearby and probably had access to meat (Bickle *et al.*, 2015: tab.38).

Figure D1_8 - Kleinhadersdorf: grave 56 (image credit: BDA / J.-W. Neugebauer).

Essenbach-Ammerbreite

The LBK cemetery and settlement of ‘Ammerbreite’ in Essenbach, Landshut county, Lower Bavaria, was discovered in 1981 during construction work on the north-western edge of the modern village. Subsequent excavations until 1986 by Henriette Brink-Kloke uncovered remains of LBK habitation and a concentration of 29 graves, ca. 40 m away, attributed to an advanced phase of the LBK. One additional burial (grave 7) was found inside a reused settlement pit in the direction of the cemetery (Brink-Kloke, 1990: 428). Only a section of the cemetery could be excavated. Graves were damaged by ploughing activities. Anthropological study of the skeletons determined that 10 were children or infants, and 15 adults or sub-adults, of which seven were female and six were male (Brink-Kloke, 1990: 433).

The individual sampled for this project (Ess7) was the child in grave 2, ca. 9-10 years old, buried in contracted position on the left side, with the head oriented to the northeast (Fig. D1_9). Grave 2 was one of the more richly furnished graves, including objects normally associated with adult males (graves 16 and 24), such as a stone axe and a complete vessel. The vessel contained the fragment of a perforated bone comb and the left, upper incisor tooth of the child (Brink-Kloke, 1990: 458). The dating of the skeleton has not been established through ^{14}C dating. The objects deposited in the grave are typical of the LBK, with the comb suggesting a ‘young’ or ‘late LBK’ date, possibly in the range 7050-6900 BP (J. Pechtl, comm.).

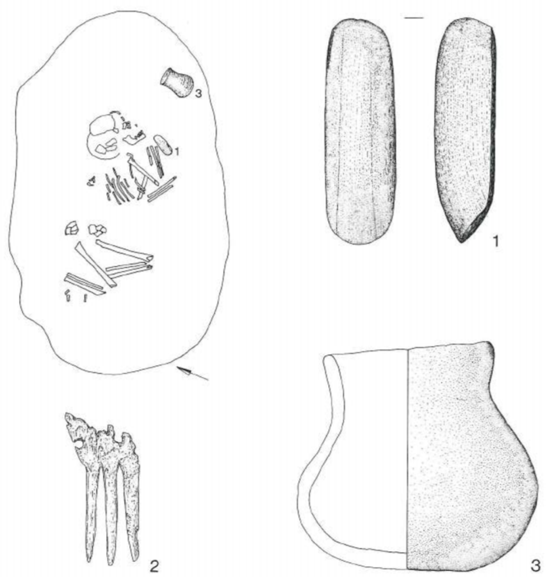

Figure D1_9 - Essenbach-Ammerbreite: content of grave 2
(image credit: Zeichnungen Bayerisches Landesamt für Denkmalpflege, Außenstelle Landshut, reproduced with permission of *Germania* (Brink-Kloke, 1990)).

Dillingen-Steinheim

Located on a high terrace with thick loess soils, between the Danube and the Egau rivers, the LBK site of 'Steinheim' near Dillingen, Swabia, was excavated during a seven-month long season in 1987 by the Bavarian State Office for the Preservation of Monuments – Augsburg (Nieszery, 1995: 60; Dietrich and Kociumaka, 2001). The site consists of a short-lived LBK settlement possibly enclosed by a ditch. Two groups of burials were reported for this site – a small burial cluster, comprising up to 27 early Neolithic graves, some distance away from the settlement (Nieszery, 1995) and a group of regular graves within the ditch (J. Pechtl, comm.). There is no evidence of massacre at Steinheim; formal inhumations in LBK ditches are common in Southern Germany. The individual sampled (Dil16) comes from the ditch, belonging to an 11-13 year old, genetically male. The new radiocarbon date obtained from this skeleton (MAMS-46039: 6200 ± 25 BP, 7235-6998 cal. BP at 2σ) confirms that the ditch was infilled in an 'older LBK' phase, ca. 7150-7050 BP (Pechtl, 2015: 16).

Herxheim

Located in the south of the Rhineland-Palatinate State in Western Germany, Herxheim is one of the most frequently discussed LBK sites in relation to Neolithic interpersonal violence alongside Schletz and Talheim. Initially a rescue excavation under Annemarie Häußer, in 1996-1999, the scientific responsibility of the project has since been entrusted to Andrea Zeeb-Lanz, from the General Directorate for Cultural Heritage Rhineland-Palatinate, who oversaw from 2005 to 2008 a new excavation and led a research project financed by the German Research Foundation (DFG) for eight years. Herxheim may have started off as a fairly conventional LBK site at around 5300 BC, enclosed during the so-called "ritual phase" by a series of elongated pits, which ended up forming two broadly parallel trapezoidal ditches or ditch segments, ca. 250 x 230 m in size; in places these run up to 4 m beneath the settlement level. Twenty-nine radiocarbon dates place the ritual phase of the settlement toward the end of the LBK, ca. 7160-7000 cal. BP at two standard deviations. Bone and pottery refits from the find concentrations in the ditches suggest a much shorter time for the rituals and the infilling of the ditch segments (Haack, 2016: 34).

The highly fragmented remains of over 500 individuals were found deposited in the two 'ditches' (Fig. D1_10), usually in heaps or scatters that also include pottery, faunal remains, stone and bone tools (Zeeb-Lanz, 2016, 2019b). The human bone assemblage is dominated by skulls, especially skull caps, which were in some cases deposited separately in little clusters. These were shaped in a regular manner, probably with the help of an adze, and often bear cut marks that indicate removal of the scalp. Individuals of all age groups and sexes are represented among the deceased. Patterns of systematic and targeted bone breakage and defleshing have led some to infer mass cannibalism at the site (Boulestin and Coupey, 2015), though the same evidence can be used to suggest ritual killing or 'sacrifice' (Zeeb-Lanz, 2019a).

Much of the pottery deposited in the pits appears to be exotic, with stylistic elements indicating connections with communities as far east as the Elbe Valley in the North of today's Czech Republic (Bohemia). Hence a question arises as to whether the dead might have come from as far as the pottery itself. Strontium isotope analysis on tooth enamel of nearly eighty individuals, including two regular LBK 'hocker' graves from the inner pit ring, shows an intriguing pattern in which those individuals that have received formal inhumation fall within the local range of variation, while disarticulated or dismembered human remains belong to 'non-locals' (Turck, 2019). The majority of the Sr-values hint at an origin of the butchered individuals from low mountain ranges, totally untypical for LBK settlement patterns.

The Pars petrosa sampled for this project (Herx), which belongs to a genetically female individual, comes from a stray skull fragment recovered in the northern end of the outer trench ring, section 281-19, excavated in 1998. The ‘ditch’ is about 2.5 m deep and V-shaped in this section, yielding only isolated human bones, faunal remains, loam and pottery fragments from a depth of 40 cm down. The infilling is likely to have taken place in the late/final LBK, ca. 7000 cal. BP, based on interpretation of the ^{14}C dates with Bayesian methods (Riedhammer, 2019) and ceramic finds including decorated sherds. The individual reported here is now ^{14}C-dated to 7164-6993 cal. BP at 2σ (MAMS 46041: 6189 ± 25 BP).

Figure D1_10 - Herxheim: one of the bigger find concentrations (image credit: GDKE - Landesarchäologie Speyer).

Palaeodietary inferences

We analysed the delta values of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) of the seven individuals for which we present new ^{14}C dates (Table D1_2). Carbon isotopes are generally used to determine the amount of marine and terrestrial proteins in ancient diets, as well as C_3 and C_4 photosynthetic pathways. Marine endpoints of $\delta^{13}C$ are -12 ± 1‰ while values from terrestrial proteins centre around -21 ± 1‰ (Cristiani *et al.*, 2018; Richards and Hedges, 1999). Nitrogen isotopes are often used to determine the trophic level of the organism within a specific ecosystem and for distinguishing between aquatic and terrestrial food sources. Terrestrial herbivores' $\delta^{15}N$ values typically range between 4 and 7‰, whereas carnivores - including humans - show values about 3-4‰ higher on average than the organisms they consume (Cristiani *et al.*, 2018; Schoeninger and DeNiro, 1982).

The $\delta^{13}C$ values of the seven individuals reported here range from -19.13‰ to -20.54‰, while the $\delta^{15}N$ values range from 8.73‰ to 15.77‰ (Table D1_2). In order to place the sampled individuals within a broader dietary context, we plotted their values together with published isotopic data from Mesolithic and Neolithic individuals of Central and Southeast Europe, Northwestern Anatolia, together with faunal remains from the same sites (Fig. D1_11).

The Neolithic individuals from Herxheim (Herx), Asparn-Schletz (Asp6) and Kleinhadersdorf (Klein7) cluster with other Neolithic individuals from Central Europe (Fig. D1_11). Without detailed examination of local food web variations, inferences made in this section remain tentative. The $\delta^{13}C$ values observed indicate a diet based on terrestrial animal protein with less plant contribution. Herx shows values suggestive of higher C_3 plant (e.g. wheat, barley, leafy vegetables) consumption, when compared with other sampled individuals. Asp6 presumably consumed more animal than plant proteins. The individual from Dillingen-Steinheim (Dil16) has lower $\delta^{15}N$ values compared to other sampled Neolithic individuals, but overall falls within the range of distribution of Neolithic farmers in Central Europe. The lower $\delta^{15}N$ may be influenced by the quality of the terrestrial proteins, meaning that the proxy includes animals lower in the food chain, i.e. herbivores ($\delta^{15}N$ values typically +5.3 ± 1.9‰).

It is worth bearing in mind that nitrogen isotopic variations differ greatly within and between ecosystems and trophic levels; herbivore bone collagen values are affected by many factors including climate, organism's physiology, *etc* (Ambrose, 1991). The Neolithic individual from Barcın (Bar25) has the lowest $\delta^{13}C$ value in the dataset and plots outside the Neolithic group. The sample's $\delta^{13}C$ intermediate value may be influenced by a mixed C_3 and C_4 (e.g. millet) plant consumption, as well as animal proteins. Nea3, the ~6-9 month old infant from Nea Nikomedeia has higher $\delta^{15}N$ value compared to other Neolithic individuals of this study, related to breast milk consumption (breastfed infants typically have 2-3‰ higher $\delta^{15}N$ values than their mother (Fogel *et al.*, 1989; Fuller *et al.*, 2006)). The Mesolithic individual from the Danube Gorges (VLASA32) has the highest $\delta^{15}N$ value, and plots outside the range of published Mesolithic individuals from Central Europe (Bickle, 2018). Its high $\delta^{15}N$ value suggests a large intake of freshwater food, primarily large fish (e.g. anadromous salmonids), and is consistent with recent published values from the Danube Gorges Mesolithic sites (Jovanović *et al.*, 2019).

Table D1_2 - Summary of the $\delta^{13}C$ and $\delta^{15}N$ values obtained from the 7 individuals analysed in this study. The values given are the nitrogen content (N [%], average of triple determination) with standard deviation (1σ; N [%] SD), the carbon content (C [%], average of triple determination) with standard deviation (1σ; C [%] SD), the atomic C:N ratio, the $^{15}N/^{14}N$ isotopic ratio (D/C $\delta^{15}N$ [‰ AIR]) relative to the standard AIR with drift correction (D/C) (average of triple determination) with standard deviation (1σ; D/C $\delta^{15}N$ [‰ AIR] SD) and the $^{13}C/^{12}C$ isotopic ratio (D/C $\delta^{13}C$ [‰ VPDB]) relative to the standard VPDB with drift correction (D/C) (average of triple determination) with standard deviation (1σ; D/C $\delta^{13}C$ [‰ VPDB] SD).

Sample ID	Collagen yield [%]	N [%]	N [%] SD	C [%]	C [%] SD	C:N	D/C $\delta^{15}N$ [‰ AIR]	D/C $\delta^{15}N$ [‰ AIR] SD	D/C $\delta^{13}C$ [‰ VPDB]	D/C $\delta^{13}C$ [‰ VPDB] SD
VLASA32	2.76	10.71	0.69	29.71	1.94	3.24	15.77	0.12	-20.13	0.09
Bar25	7.07	15.97	0.08	43.79	0.09	3.20	10.20	0.01	-19.13	0.04
Nea3	5.18	12.87	0.79	35.37	1.88	3.21	11.88	0.03	-19.91	0.07
Klein7	1.00	10.07	0.29	28.38	0.80	3.29	9.65	0.02	-20.31	0.06
Dil16	2.76	13.57	0.23	36.95	0.72	3.18	8.73	0.08	-20.52	0.02
Asp6	1.16	7.17	0.97	21.54	2.81	3.51	10.01	0.14	-19.97	0.07
Herx	6.75	14.39	0.13	39.32	0.16	3.19	10.28	0.02	-20.54	0.01

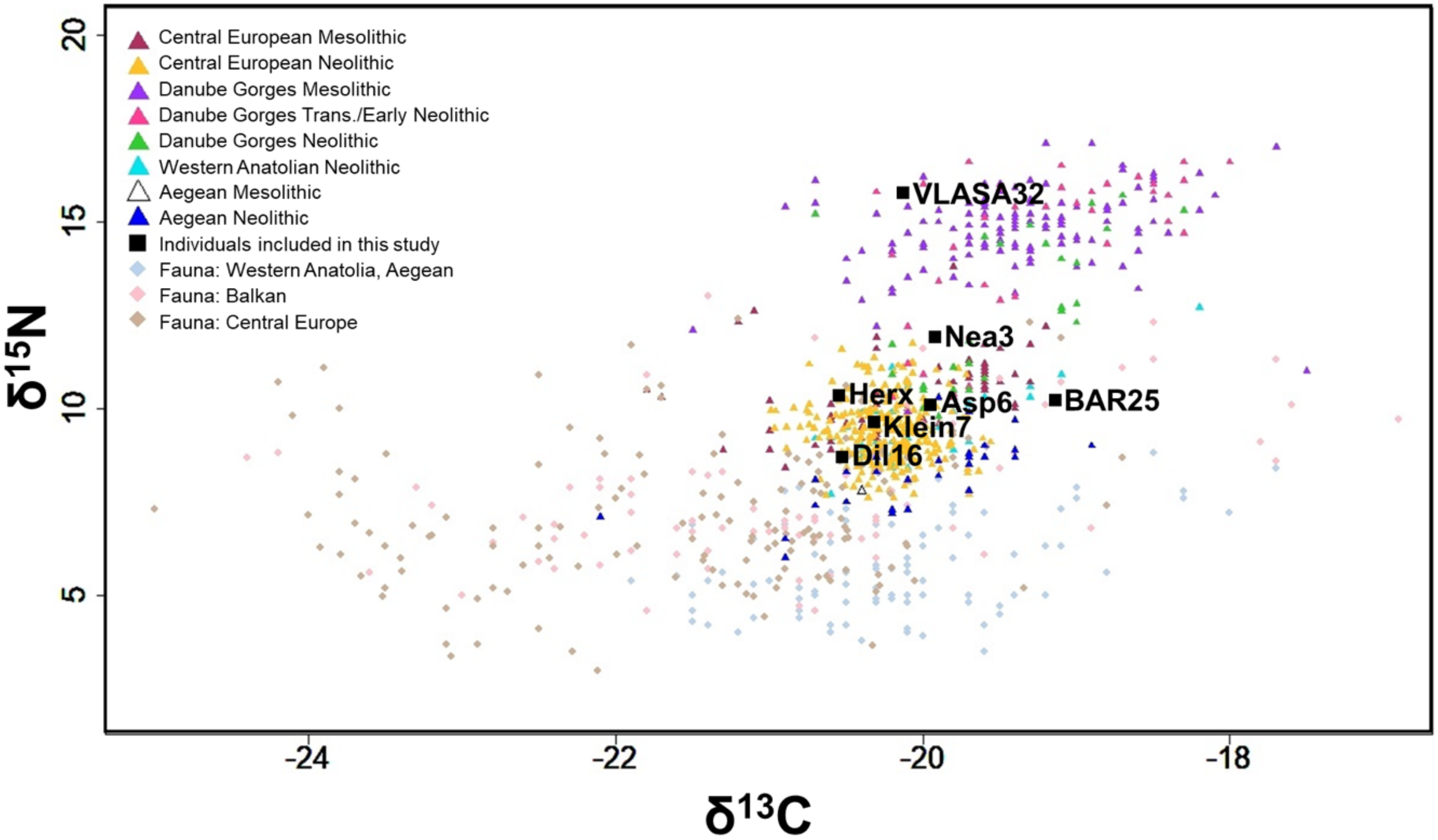

Figure D1_11 - δ^{13}C and δ^{15}N values obtained from the individuals analysed in this study and published data from 613 Neolithic and Mesolithic humans from Central Europe (Bickle, 2018), the Danube Gorges (Bonsall *et al.*, 1997, 2008, 2015, 2016; Borić, 2011, 2019; Borić and Price, 2013; Cook *et al.*, 2001; Jovanović *et al.*, 2019; Mathieson *et al.*, 2018; Nehlich *et al.*, 2010), the Aegean Basin (Mathieson *et al.*, 2018; Papathanasiou, 2003, 2011) and NW Anatolia (Budd *et al.*, 2013, 2018; Mathieson *et al.*, 2018). Published faunal values from the same period/regions are included for comparison (Borić, 2011; Budd *et al.*, 2013, 2018; Jovanović *et al.*, 2019; Nehlich *et al.*, 2010; Papathanasiou, 2015; Vaiglova *et al.*, 2014).